the county seat of Dakota County, where considerable property damage was done. The tornado dissipated about 4:30 p. m. one-half mile north of Dakota City, after having traversed a path of 33 miles across north-central Cuming County, diagonally across central Thurston and the eastern border of Dakota County, Nebr.

The path averaged from a few rods to three-fourths of a mile in width. Except for a distance of about 2 miles the funnel-shaped cloud, which was seen by reliable people over the whole course, never left the ground. Hail, not heavy, but large stones, fell with rain preceding the storm. The sky cleared rapidly after the passage of the tornado and a few observers reported that no rain fell at the time the storm struck. The cloud as a rule, was described as being jet black, with the usual grinding noise heard, timbers, straw, and débris being scattered by the whirling mass. Although the storm dissipated 5 miles southwest of Sioux City, straw, corn stalks, and leaves that had been hurled into the air were scattered over the city between 4:30 and 5 p. m.

Since the occurrence of this tornado, much has been said about a supposed old Indian legend to the effect that Sioux City is safe from tornadoes due to the convergence of three rivers—namely, the Big Sioux, the Floyd, and the Missouri. Previous disasters from the same cause do not warrant faith in such a fallacy, although many firm believers point to the dissipation of this storm within 5 miles of the Missouri River to prove their contentions. This writer has been commended by insurance writers in an article appearing in the daily press for holding such a theory as improbable.

Conforming to the general rule, the Pender tornado formed in the southeastern quadrant of a general cyclonic disturbance. It originated approximately 275 miles to the southeast of the main center. So far as known the only photograph of the storm was taken near Pender, a copy of which is inclosed. Witnesses in that section stated that the funnel when it first formed was made up of several sections, reaching upward from the ground to the main storm cloud, from which small jets of white cloud having the appearance of steam were emitted at intervals. As the cloud lowered the different sections merged into a whirling mass.

The maximum temperature chart for the afternoon of September 13 showed a sharp temperature gradient over the middle Great Plains States, ranging from 96° at Concordia, in north-central Kansas, to 52° at Cheyenne in southeastern Wyoming. The direct cause perhaps was due to the underrunning of the cold currents from the high barometric pressure area that was approaching the middle Rocky Mountain region. The air was very oppressive immediately before the storm struck, as evidenced by noon humidity readings of 72 per cent at Sioux City and 82 per cent at Yankton.

A number of eyewitnesses saw the cloud that wrought havoc dissipate. Mr. E. L. Vannard, secretary of the Morningside Country Club, who with two others was watching the storm from the clubhouse located in the southeastern portion of Sioux City, states that a tree of moderate proportions dropped from the sky within a few feet from where they were standing and that a bundle of oats fell on the golf course. He saw a well-defined black funnel cloud approaching from the southwest, when suddenly it became disconnected and the upper portion seemed to draw up in the clouds while the lower section became disjointed and quickly faded out and disappeared on the ground.

The storm reached Sioux City in the form of a thunderstorm from the south, first heard at 3:56 p. m. and last heard at 4:59 p. m. Rain fell from 3:48 p. m. to 4:50 p. m., amounting to 0.99 inch. A trace of hail was recorded from 4:16 to 4:25 p. m. The maximum velocity of the wind for a 5-minute period was 30 miles from the southeast beginning at 4:31 p. m., with an extreme velocity of 46 miles. The barometer fell gradually from 7 a. m. till 3 p. m. and then quite abruptly till 4:25 p. m., when it reached a sea-level reading of 29.50 inches, the lowest recorded. Then there was a sharp rise making a graph similar to the passage of a thunderstorm.

Summary of damage furnished by the courtesy of American Red Cross

	Nebraska		South Dakota		Combined	
	Number	Value	Number	Value	Number	Value
Dead	4		4		8	
Injured	52		9		61	
Families homeless	51				51	
Families registered	153		20		173	
Number of individuals	846		97		943	
Livestock killed:						
Horses	86	$4,300	1	$50	87	$4,350
Cattle	126	12,600	10	1,000	136	13,600
Hogs	1,280	19,200	339	5,085	1,619	24,285
Poultry	9,525	9,525	2,165	2,165	11,690	11,690
Schools destroyed	3	7,000			3	7,000
Dwellings destroyed	41	102,500	25	62,500	66	165,000
Dwellings damaged	67	67,000	36	36,000	103	103,000
Business houses destroyed			27	67,500	27	67,500
Farm buildings destroyed	222	111,100	42	22,100	264	133,200
Farm buildings damaged	237	47,400	46	9,200	283	56,600
Farm implement sets destroyed	72	36,000	14	7,000	86	43,000
Farm implement sets damaged	77	15,400	16	3,200	93	18,600
Acres corn destroyed	5,399	107,980	515	10,300	5,914	118,280
Acres other crops destroyed	22,581	225,810	2,060	20,600	24,641	246,410
Total		765,815		246,700		1,012,515

THE ROCKFORD, ILL., TORNADO, SEPTEMBER 14, 1928

By FRED H. WECK, Assist. Meteorologist

[Cicero Aviation Field, Chicago, Ill.]

The Rockford tornado originated in an area of low pressure which covered the Northern Plains States on Thursday, September 13, and was central over central Minnesota on the morning of September 14. On the afternoon of the 14th, the day of the storm, special reports indicated that the center was located in eastern Minnesota with a barometer reading of 29.46 inches, sea level.

The tornado developed in the southeastern portion of the depression and about 200 miles from the center. It descended to earth at the southern city limits of Rockford, a city of about 85,000 people, and moved northeastward over the southeastern portion of the city for a distance of about 2¼ miles, affecting more than 30 city blocks. Passing across the Grant Highway east of town it moved into the country.

The first evidence of destruction was observed just outside of the city limits, where the roof and one gable were removed from a cottage. About 500 feet farther on a small dwelling, sheltering a family of 6, was completely demolished and the débris scattered over an open field for several hundred yards. While the parents were painfully injured and the children cut in numerous places all escaped death. To the northward at the adjacent house a man was found dead in the yard after the storm,

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Ruins of chair factory in which eight persons were killed and many injured

Frame cottage turned upside down

his death probably caused by flying timber. Here the path was about 200 feet wide.

The next damage was the destruction of a chair factory, housed in a large brick-veneered structure of three floors and basement. Although 114 men were at work when the building collapsed only 8 were killed; however, almost two score were injured. The factory was evidently directly in the path of the storm, for the roof lifted and the sides fell, some inward and some outward.

Sweeping toward the northeast the storm cut a swath about 300 feet wide through alternating factory and residence districts, missing a grade school by several hundred feet. At one point, about 500 feet north of the storm track, 4 boys, 14 to 17 years old, were hurrying home to escape the storm when a garage roof came hurtling through the air. Two of the boys were killed instantly and a third died later. The fourth was unhurt. Lifting the roofs from dwellings, breaking windows, tearing off porches, and uprooting trees as it proceeded the storm did further damage by removing the south wall of a factory, dropping the contents of the second and third floors, including a large water tank, to the basement. Two men were killed.

Moving on through an area of residence, narrowly missing two more schools it hit a factory section, blowing out the south wall of one building and the north wall of another across the street to the south. With a path 400 feet wide it crossed a railroad, and passed over a section of new homes, missing the fourth school by 1 block, moving 2 adjacent houses out in the street with not a great deal of harm, damaging other residences with more or less severity. From this point the houses were scattered and open country was soon encountered. There was some skipping and scattered damage reported as far as Chemung. Several farm buildings were partially demolished and shade trees were broken down.

The visibility was good during the passage of the storm cloud, as workmen on a new building 3 miles away reported they saw the funnel-shaped cloud. There was much evidence of counter-clockwise motion and several walls were blown out. Débris was tossed out of the path toward the north. Porch roofs and eaves troughs were lifted and deposited on the main roofs, evidence of ascending air currents. The better class of structure withstood the storm's fury. A large reinforced concrete stack in the path was unharmed. There were some reports of hail, a very small amount. There was a moderate rain and some lightning. No fires were started.

The tornado struck the chair factory at 3:22 p. m. The exact time of other damage could not be determined with certainty, but the storm passed 2 miles south of Argyle and 1 mile north of Poplar Grove at 3:40 p. m., and the damage near Capron occurred near 4 o'clock. These facts indicate a velocity of forward movement of about 40 miles per hour. The length of the path was about 25 miles, the width varying from 200 to 500 feet. Fourteen deaths occurred and about 100 persons were injured in Rockford alone. Two hundred buildings were damaged or destroyed and the total property loss will amount to approximately $1,200,000.

THE DISTRIBUTION OF EXCESSIVE PRECIPITATION IN THE UNITED STATES

By ALFRED J. HENRY

Excessive rains as defined by the United States Weather Bureau may be conveniently grouped as follows:

Class A. Twenty-four-hour rains equalling or exceeding 2.50 inches.
Class B. Five-minute rains equalling or exceeding 0.25 inch.
Class C. One-hour rains equalling or exceeding 1 inch; in the later records as much as 0.80 inch in an hour is considered as excessive.

This classification is based essentially upon a time scale of heavy rains. For the full 24 hours any rain of 2.50 inches or more, regardless of the fact that it may have fallen in but 1 or 2 hours, is put into the same class as those which may have fallen at a uniform rate of but 0.104 inch per hour. It is possible, therefore, that a particular rain may be classed in two groups. A still further classification based on the month as a time unit was in use for a time in the early years of the Federal Weather Service. Ten inches per month was considered as excessive.

A rainfall of 0.25 inch in 5 minutes (class B) is, of course, equivalent to the rate of 6 inches per hour. The amount of rain that falls in any 5-minute period rarely exceeds 0.50 inch as a maximum.

In assembling the statistics for the above-named groups the 24-hour rains form a class by themselves, since they are drawn almost exclusively from stick measurements of the ordinary rain gage and eye observations of the times of beginning and ending of the rain.

Classes B and C on the other hand are drawn mainly from automatic records of rainfall that give both intensity and duration of the fall. In a small number of cases stick measurements of very intense rains whose time of beginning and ending is accurately known have been used.

TWENTY-FOUR-HOUR RAINS

The 24-hour rains equalling or exceeding 2.50 inches have been tabulated by States and for the year and also for the 3 summer months separately. The period covered by the tabulations is the same, viz, 1871–1894. A total of 3,886 records of which 357 were for summer months was used. The ratio of summer to annual frequency is, therefore, about as 1:10. West of the Rocky Mountains there is almost an entire absence of heavy rains in summer due to lack of moisture in the atmosphere and the prevailing high temperature.

The winter rainy season on the Pacific coast yields on the average about 40 heavy daily rains per season, practically all of them being associated with traveling cyclonic storms. East of the Rocky Mountains the convective rains of summer added to those associated with cyclonic storms, cold fronts, etc., increases the total number of these rains to more than double the number experienced on the Pacific coast.

It is commonly held and apparently with justification that the total precipitation decreases with distance from the chief storehouse of water vapor—the oceans. Whatever the precise relation may be it is modified by the topography of the lands bordering the oceans and the direction of the prevailing winds and even more profoundly by the temperature-altitude relations, a subject that will be more fully touched upon later.

Figure 1 shows the distribution of Class A rains for the year and Figure 2 that for the three summer months of June–August. The distribution shown in the annual chart resembles somewhat that of the annual depth of